(19) Eur päisches Patentamt
European Patent Office
Office europé n des brevets

(11) EP 0 781 917 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
02.07.1997 Bulletin 1997/27

(51) Int. Cl.^{6}: **F02M 61/18**, F02M 51/08

(21) Application number: 96203325.4

(22) Date of filing: 26.11.1996

(84) Designated Contracting States:
DE FR GB

(30) Priority: 26.12.1995 US 578850

(71) Applicant: GENERAL MOTORS CORPORATION
Detroit Michigan 48202 (US)

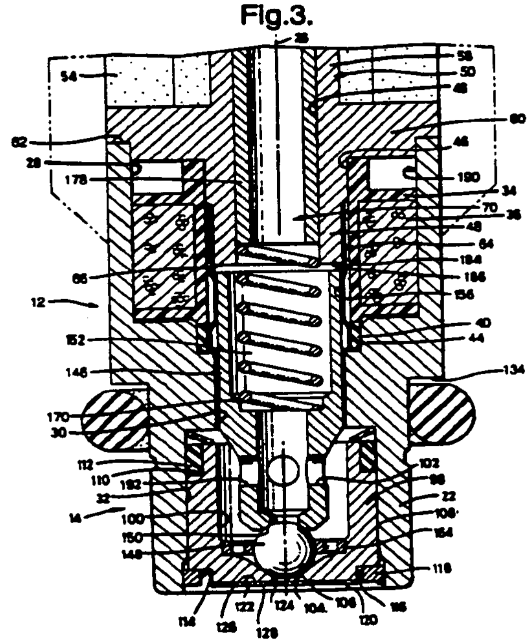
(72) Inventors:
- Bonnah, Harrie William, II
East Grand Rapids, Michigan 49506 (US)
- Vanderhenst, John David
Grand Rapids, Michigan 49507 (US)

(74) Representative: Denton, Michael John
Patent Section
1st Floor
Gideon House
28 Chapel Street
Luton Bedfordshire LU1 2SE (GB)

(54) Fuel injector valve seat retention

(57) A fuel injector is disclosed and has a tubular injector body with a fuel passage (70) extending therethrough. A solenoid actuator is disposed intermediate of the fuel passage and a nozzle body (98), having a fuel opening (104) surrounded by an annular valve seat (106) is located downstream of the actuator, between the actuator and an end of the passage. The nozzle body (98) is configured for sliding engagement with the inner wall of the fuel passage and a valve assembly operates with the solenoid actuator and the nozzle body (98) to meter fuel through the annular valve seat (106). A radially outwardly biased ring member (118) is disposed in the fuel passage, between said nozzle body (98) and the end of the fuel passage and operates to exert an outwardly directed force ("F") on the inner wall of the tubular injector fuel passage to thereby establish a frictional resistance to axial movement of the nozzle body (98) towards the end of the fuel passage. In a preferred embodiment, the retainer ring (118) abutting a lower surface of the nozzle body in an annular grooved portion (116) thereof to thereby recess the retaining ring (118) in the nozzle body lower surface and minimize the surrounding surface area which is subject to fuel wetting. The retaining ring (118) may be welded to the nozzle body (98) and the tubular injector body to fix the nozzle body axially.

Fig.3.



EP 0 781 917 A1

Printed by Rank Xerox (UK) Business Services
2.14 8/3.4

Description

TECHNICAL FIELD

The present invention relates to fuel injectors for delivery of fuel to the intake system of an internal combustion engine.

BACKGROUND OF THE INVENTION

Electromagnetic fuel injectors used in internal combustion engines are capable of effectively controlling the discharge of a precise metered quantity of fuel per unit time to the engine intake. Proper metering and atomization of fuel discharged from the injector is desirable for a homogeneous fuel/air mixture. Of paramount importance in the preparation of fuel spray is the configuration and adjustment of the injector valve and valve seat as well as the design of the fuel director and surfaces surrounding the discharge end of the fuel injector.

Adjustment and retention of the valve seat nozzle within the fuel injector body is commonly through cooperating threaded surfaces on the two components. The threads allow for axial positioning of the valve seat relative to the valve assembly thereby defining the axial travel of the armature/valve. In addition the threaded surfaces axially fix the valve seat within the nozzle body.

Use of cooperating threaded surfaces is costly in terms of machining, required to form the precise threads and is subject to contamination by dirt and debris which can result in difficulty or damage during injector assembly. Additionally, in order to safeguard against rotation of the valve seat within the nozzle body during operation, the two components must be fixed in position, as be welding, following adjustment. Welding of the two components, the materials of which have been selected principally for hardness and resistance to fuel degradation, may not provide optimum results.

SUMMARY OF THE INVENTION

Accordingly it is an object of the present invention to provide a fuel injector, for use in an internal combustion engine, having a valve seat assembly, or nozzle body, which is located within an associated fuel injector body using a locating feature operable to frictionally position the valve seat within the nozzle.

An embodiment of the invention provides such a valve seat locator which permits adjustment of the valve seat following assembly. Such adjustment is achieved by exceeding the frictional forces which function to position the valve seat in the injector body and allows movement of the valve seat in one or both directions along the valve axis.

Another feature and advantage of the valve seat positioner of the present invention may be the reduction in surface area surrounding the discharge end of the nozzle. Such reduction in area can be achieved through location of the retainer ring in an axial, annular recess in the valve seat body to reduce the incidence of injector tip surface wetting which may adversely impact cylinder fueling.

A further feature and advantage of the retaining ring for injector valve seats, of the present invention, may be the flexibility in material choice in constructing the ring. Permanent fixing of the valve seat nozzle within the fuel injector body may be through welding of the nozzle body to the retaining ring and the retaining ring to the injector body. Through selection and matching of the material properties of the retaining ring to those of the nozzle and the injector body, the weld characteristics at the junction may be maximized.

An embodiment of the present invention is described below, by way of example only, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of a fuel injector embodying features of the present invention;

Figure 2 is a partial sectional view of Figure 1, with parts removed for clarity;

Figure 3 is an enlarged cross section of a portion of Figure 2;

Figure 4 is a bottom view of the fuel injector of Figure 1;

Figure 5 is a partial sectional view of the fuel injector of Figure 1 taken along line 5-5 of Figure 4;

Figure 6 is a bottom view of the fuel injector of Figure 1 illustrating an alternative embodiment of the present invention; and

Figure 7 is a partial sectional view of the fuel injector of Figure 6 taken along line 7-7 of Figure 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figures 1, and 2, an electromagnetic fuel injector, designated generally as 10 includes, as major components thereof, a body 12, a nozzle assembly 14, a valve member 16 and a solenoid actuator assembly 18 used to control the movement of the valve member 16.

In the construction illustrated, the injector body 12 is of cylindrical, hollow tubular configuration and is of such external shape as to permit direct insertion, if desired, of the injector 10 into a socket provided for this purpose in an engine intake manifold, not shown.

The body 12 includes an enlarged upper solenoid case portion 20 and a lower end, nozzle case portion 22 of reduced internal and external diameter relative to the solenoid portion 20. An internal cylindrical cavity 24 is formed in the body 12 by a stepped bore therethrough that is substantially coaxial with the axis 26 of the body. In the construction shown, the cavity 24 includes a cylindrical upper wall 28, a cylindrical intermediate wall 30 and a cylindrical lower wall 32. Wall 30 is of a reduced diameter relative to upper and lower wall portions 28 and 32, respectively.

Solenoid assembly 18 is disposed within the enlarged upper solenoid case portion 20 and includes a spool-like, tubular bobbin 34 supporting a wound wire solenoid coil 36. A resilient sealing member such as o-ring 40 is disposed between the tubular bobbin 34 and a seal shoulder 44. The bobbin 34 is provided with a central through bore 46 configured to encircle the lower, reduced diameter portion 48 of pole piece 50. A pair of terminal leads 52 are operatively connected at one end to the solenoid coil 36 and each such lead has its second end extending upwardly through an outer, overmolded casing 54 to terminate in a terminal socket 56, for connection of the fuel injector to a suitable source of electrical power in a manner well known in the art.

Pole piece 50 includes an upper cylindrical portion 58, a centrally located flange portion 60 and the lower reduced diameter cylindrical pole 48. The circular, radial flange portion 60 is slidably received at its outer peripheral edge within the cylindrical upper wall 28 of the body 12 to thereby close the enlarged upper solenoid case portion 20 of the body 12 and retain the solenoid assembly 18 therein. The pole piece 50 is axially retained within the upper cylindrical portion of the body 12 as by having its flange portion welded or otherwise suitably bonded to the shoulder 62 along the upper, opened end of wall 28.

Formed integral with the pole piece 50 and extending downwardly from the flanged portion 60 is the lower cylindrical pole 48. Pole 48 is of a suitable exterior diameter so as to be slidably received in the central through bore 46 that extends coaxially through the coil bobbin 34. Received about the lower end of the lower cylindrical pole 48 of the pole piece 50 is a cylindrical tube 64 of non-magnetic material such as stamped or drawn metal. The tube 64 extends axially downwardly beyond the lower end 66 of the lower cylindrical pole 48. The outer surface of the extended portion of the tube 64 acts as an interface with resilient sealing member 40 seated between the lower end of the coil bobbin extension 42 and seal shoulder 44 of the body 12, thereby operating to seal the central, fuel passage 70 of the fuel injector 10 from solenoid coil 36.

The pole piece 50, is provided with a boss 58 which is configured to receive fuel inlet tube 74. The fuel inlet tube 74 is encapsulated within overmolded upper housing 54 which is formed of a suitable encapsulant material. An upper seal shoulder 86 formed in the overmolded housing 54 is axially spaced from the tube flange 78 to define an annular seal groove 88 configured to carry a resilient sealing member such as o-ring 90 for leak free attachment to a source of pressurized fuel, not shown.

The nozzle assembly 14 includes a nozzle body 98 having a cup-shaped tubular configuration with an inner wall 100 defining a fuel cavity 102. The fuel cavity includes an axially aligned fuel discharge opening 104 surrounded by a frustoconical valve seat 106. A cylindrical outer wall 108 further defines the n zzle assembly 14 and is configured for sliding disposition within the cylindrical lower wall 32 of the nozzle case portion 22 of injector body 12. A circumferentially extending annular groove 110 is disposed in the cylindrical outer wall 108 adjacent the end of the nozzle body 98 and is configured to receive a resilient sealing member such as o-ring 112. The o-ring 112 establishes a seal against leakage out of the injector 10 by interfacing with the cylindrical lower wall 32 of the injector body 12.

In a preferred embodiment of the injector 10, Figures 4 and 5, a circumferentially extending shoulder 114 is disposed in the downstream, outer surface 108 of the nozzle body 98. Upon disposition of the nozzle body 98 within the lower end, nozzle case portion 22 of the injector body 10, the cylindrical lower wall 32 and the shoulder 114 of the nozzle body cooperate to define a groove 116 in which is disposed an outwardly biased, circular retaining ring 118. The retaining ring 118 is operable to exert a radially outwardly directed force "F" on the cylindrical lower wall 32 of the nozzle body 98 which, in turn, establishes a frictional resistance to axial movement of the ring and associated nozzle body within the lower case portion of the nozzle body 12.

In one preferred embodiment of the retaining ring, illustrated in Figure 4, the ring 118 is defined by non-uniform cross-section. The use of a ring 118 having such non-uniform cross-section allows for a uniform, radially outwardly directed force to be imparted by the retaining ring on the cylindrical wall 32 as compression of a ring having such a cross-section is known to impart a more uniform force component about its circumference than one having a uniform cross section.

Over a portion of the exterior, lower end 120 of the nozzle body 98 is placed a fuel spray director plate 122. The director plate 122 is a flat plate member formed of thin sheet stock and having fuel directing openings 124 extending from the upstream side 126 to the downstream side 128. Fuel passing through the fuel discharge opening 104 in the valve seat 106 is delivered to the upstream side, or face 126 of the director plate 122 where it is distributed across the face to the fuel openings 124. The openings 124 are oriented in a predetermined configuration which will generate, in the discharged fuel, a desired spray configuration. By locating the nozzle retaining ring 118 within the groove 116 formed through the association of the shoulder 114 and lower cylindrical wall 32 of body 12, the ring is recessed relative to the lower surface 122 of the nozzle body 98 to limit the surface area which is exposed to the spray departing the openings 124 in the director plate 122. Such reduction in downstream surface area is desirable in that it reduces the incidence of fuel impingement on such surfaces and wetting of those surfaces which may adversely affect the performance of the fuel system.

Assembly and calibration of the fuel injector 10 may require axial translation of the nozzle body 98 to set the stroke of the valve member 16. The use of the retaining ring 118 adjacent the downstream end of the nozzle body 98 allows the injector 10 to be assembled and the nozzle body to be axially adjusted during calibration

through imposition of an axial force component which is sufficient to overcome the frictional resistance to movement established by the radially outwardly exerted force "F" of the ring 118 on the inner cylindrical wall 32. Through its reliance on friction to retain the nozzle body within the lower case portion during assembly and calibration of the fuel injector 10, the ring 118 allows infinite adjustment of the valve stroke which would not be possible if the ring were required to seat in a groove in the lower cylindrical wall 32.

Figures 6 and 7 illustrate one alternate embodiment in which a non-uniform outer circumferential surface 130 may be utilized to increase frictional resistance to axial movement of the retainer and associated nozzle body. The outwardly extending protrusions 132 of the ring member 118' significantly increase resistance to movement, through deformation as illustrated in Figure 7 or through concentrated force component "F_1", and may provide a retainer ring which is limited to a single direction of axial adjustment.

Following calibration of the injector, the nozzle body may be permanently fixed in position within the injector body 12 by welding the nozzle body 98 to the retaining ring 118 and the retaining ring to the injector body 12, effectively using the retaining ring as weld stock. The advantage of the retaining ring 118 in this respect is that its material properties may be chosen to maximize the weld quality between the nozzle body 98 and the injector body 12 which is typically not a possibility when the two injector components are directly welded.

Referring now to the valve member 16, it includes a tubular armature 146 and a valve element 148, the latter being made of, for example, a spherical ball having a predetermined radius, which is welded to the lower annular end 150 of the tubular armature 146. The radius of the valve element 148 is chosen for seating engagement with the valve seat 106. The tubular armature 146 is formed with a predetermined outside diameter so as to be slidable within the central aperture portion 156 defined by the non-magnetic cylindrical tube 64 received about and extending from the lower pole piece 48.

Positioned within the cylindrical cavity 102 of the nozzle body 98, adjacent the valve seat 116, is an annular valve guide 164 which extends about the valve ball member 148 and is operable to guide the member as it moves reciprocally into and out of engagement with the valve seat 106.

The valve member element 148 of valve member 16 is normally biased into a closed, seated engagement with the valve seat 116 by a biasing member such as valve return spring 170 of predetermined spring force which is inserted into the tubular armature 146. A calibration sleeve 178 adjusts the spring preload exerted on the valve member 16 in the direction of the valve seat 106.

A working air gap 184 is defined between the working surface 186 at the upper end of armature tube 146 of the valve member 16 and the working surface 66 at the lower end of the pole piece 50. Upon en rgization of the solenoid assembly 18, the tubular armature 146 and associated valve element 148 is drawn upwardly and off of the valve seat 106 against the bias of the spring member 170 to close the working air gap 184. Fuel flows from the pressurized source into the first, inlet end 76 of injector 10, and enters the body 12 through the pole piece 50. Fuel flows through the tubular armature 146 and into the fuel chamber 112 in nozzle body 98 through circumferentially spaced openings 192 in the second end of the armature tube 146. The fuel exits the valve body 98 through the opening 104 in valve seat 106. Fuel exiting the valve seat 106 is distributed onto the upstream side 126 of the fuel director plate 122 where it is distributed to the fuel director orifices 124 passing through the plate, for discharge from the fuel injector 10. Deenergization of the solenoid assembly 18 allows the field within the magnetic circuit defined by the pole piece 50, the body 12, and the armature 146 to collapse thereby allowing the valve member to return to the closed position against the valve seat 106 under the bias of the spring member 170 to stop the flow of fuel therethrough.

The foregoing description of the preferred embodiment of the invention has been presented for the purpose of illustration and description. It is not intended to be exhaustive nor is it intended to limit the invention tot he precise form disclosed. It will be apparent to those skilled in the art that the disclosed embodiments may be modified in light of the above teachings. The embodiments described were chosen to provide an illustration of the principles of the invention and of its practical application tot hereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. Therefore, the foregoing description is to be considered exemplary, rather than limiting, and the true scope of the invention is that described in the following claims.

Claims

1. A fuel injector comprising a tubular injector body (12) defining an axial fuel passage (70), a nozzle body (98) configured for sliding disposition within an end of said fuel passage and a radially outwardly biased ring member (118), disposed between said nozzle body and said end of said fuel passage and operable to exert a radially outwardly directed force on said axial fuel passage of said injector body to thereby establish a frictional resistance to movement of said nozzle body within said fuel passage.

2. A fuel injector, as defined in claim 1, said ring member (118) comprising a non-uniform cross-section effective to impart a uniform, radially outwardly directed force on said axial fuel passage (70) of said injector along a line of contact therebetween.

3. A fuel injector, as defined in claim 1, said nozzle body (98) axially adjustable within said fuel passage (70) of said injector body (12), through imposition of an axial force component sufficient to overcome said frictional resistance of said retaining ring.

4. A fuel injector, as defined in claim 1, said retaining ring weldable to said nozzle body and said injector body.

5. A fuel injector comprising a tubular injector body having a fuel passage (70), defining an inner wall (28,30,32), having first and second ends, a solenoid actuator (18) disposed intermediate of said first and second ends, a nozzle body (98), comprising a fuel opening (104) surrounded by an annular valve seat (106), located between said solenoid actuator and said second end, in sliding engagement with said inner wall, a valve assembly (148) operable with said solenoid actuator and said nozzle body to meter fuel through said injector, and a radially outwardly biased ring member (118), disposed in said fuel passage, between said nozzle body and said second end of said fuel passage and operable to exert an outwardly directed force on said inner wall to thereby establish a frictional resistance to axial movement of said nozzle body in the direction of said second end and said nozzle body axially adjustable through imposition of an axial force component sufficient to overcome said frictional resistance to axial movement of said retaining ring.

6. A fuel injector, as defined in claim 5, said retaining ring comprising a non-uniform cross-section effective to impart a uniform, radially outwardly directed force on said axial fuel passage of said injector along a line of contact therebetween.

7. A fuel injector, as defined in claim 5, said retaining ring weldable to said nozzle body and said injector body.

Fig.1.

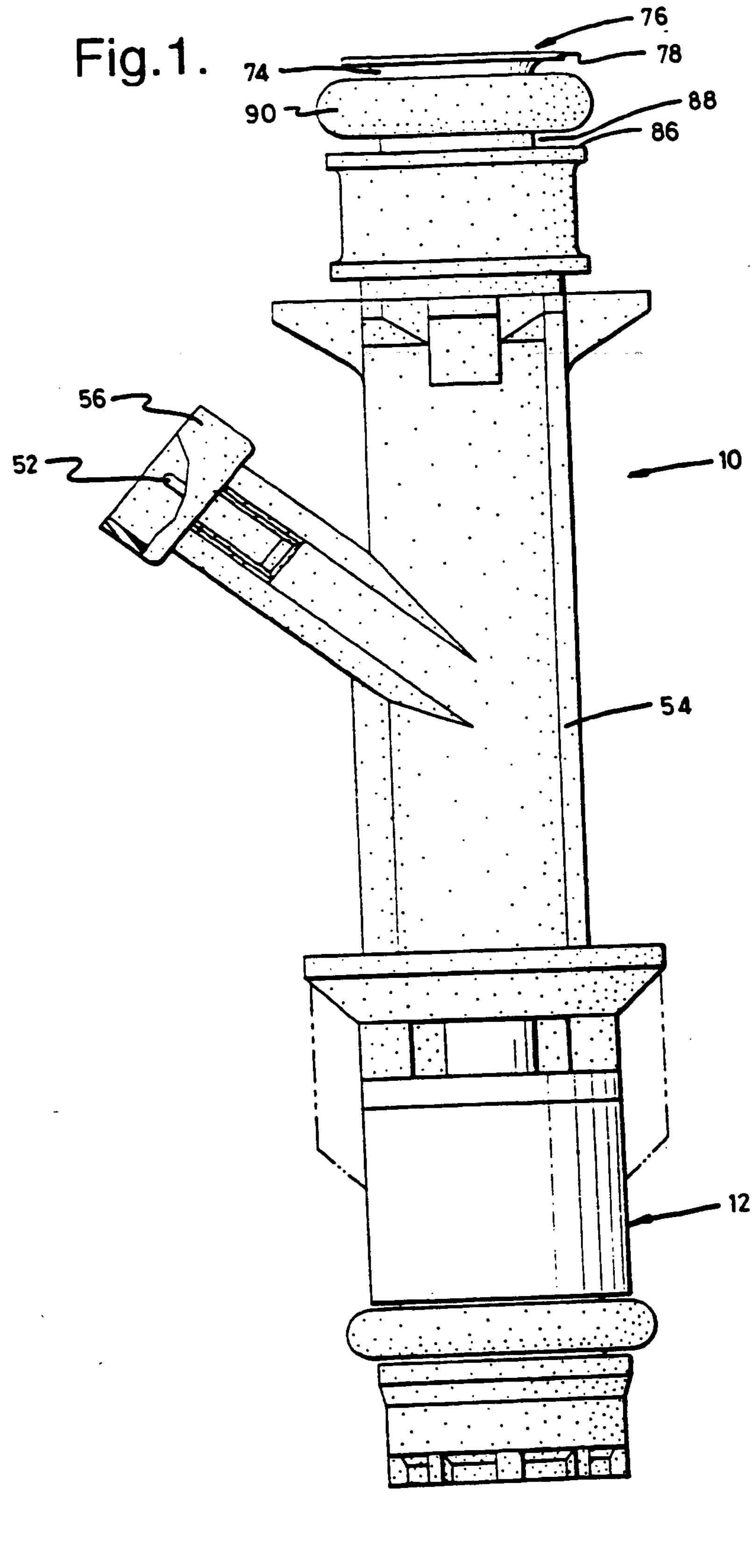


Fig.2.

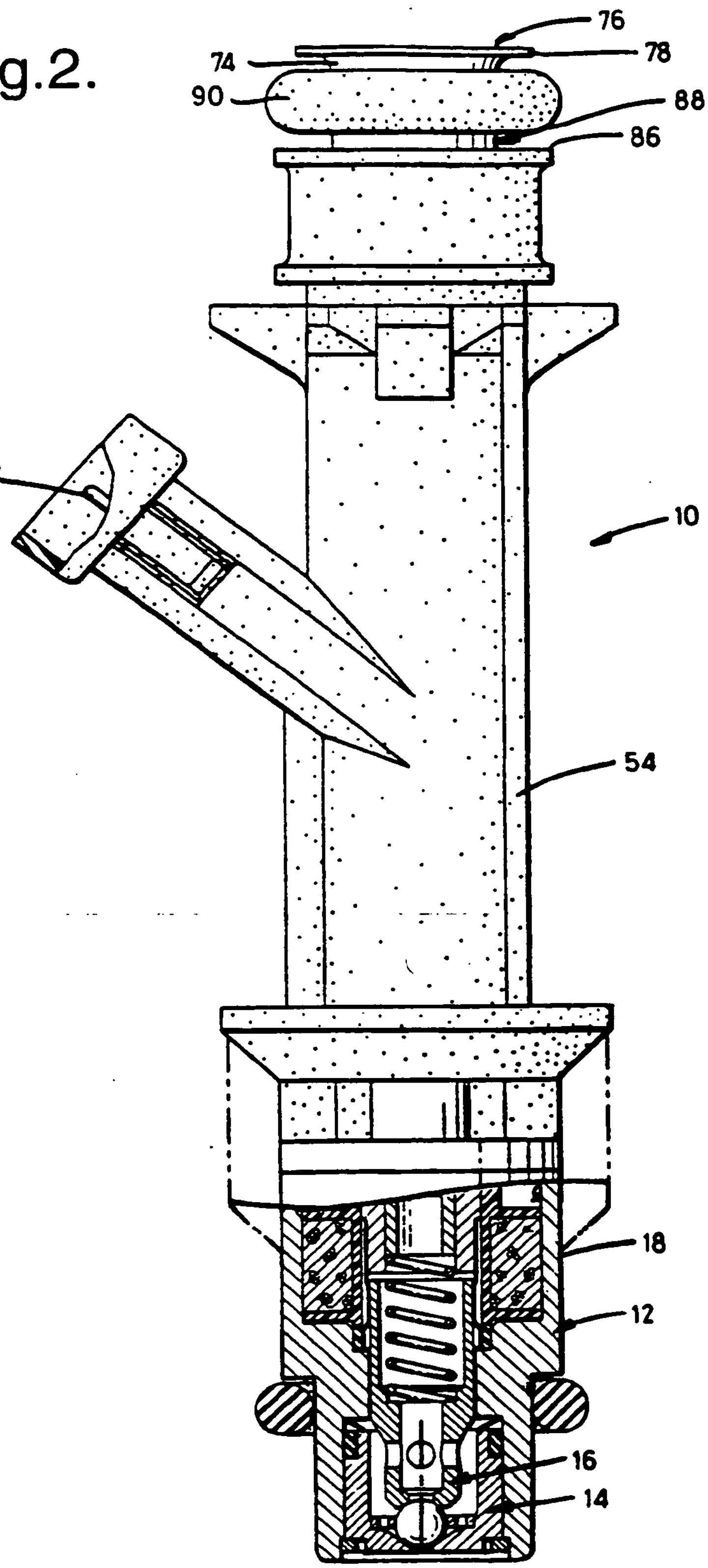


Fig.3.

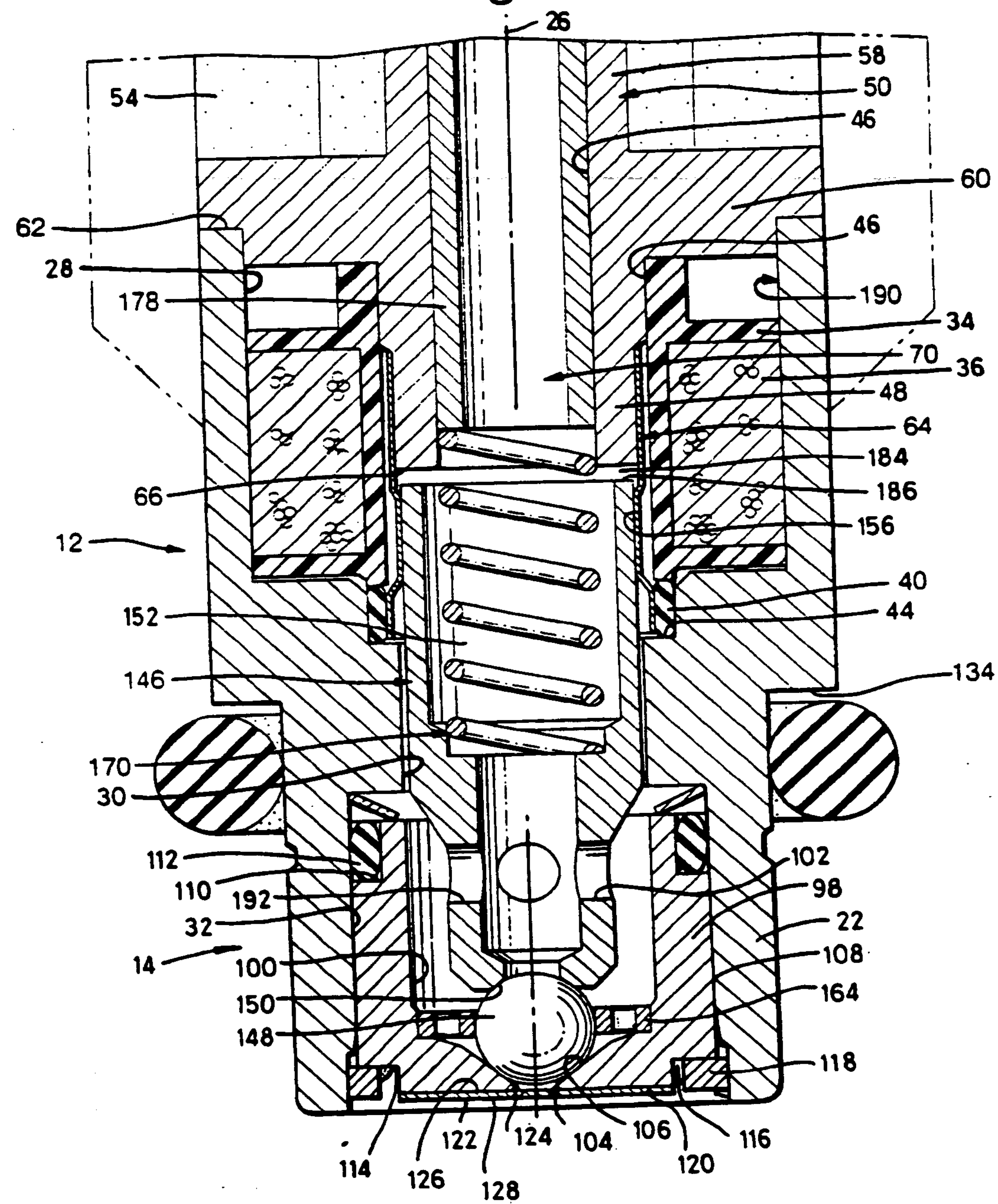

26
58
54
50
46
60
62
46
28
178
190
34
70
36
48
64
184
66
186
156
12
40
152
44
146
134
170
30
112
102
110
98
192
22
32
108
14
100
164
150
148
118
114
126
122
124
104
106
120
116
128

Fig.4.

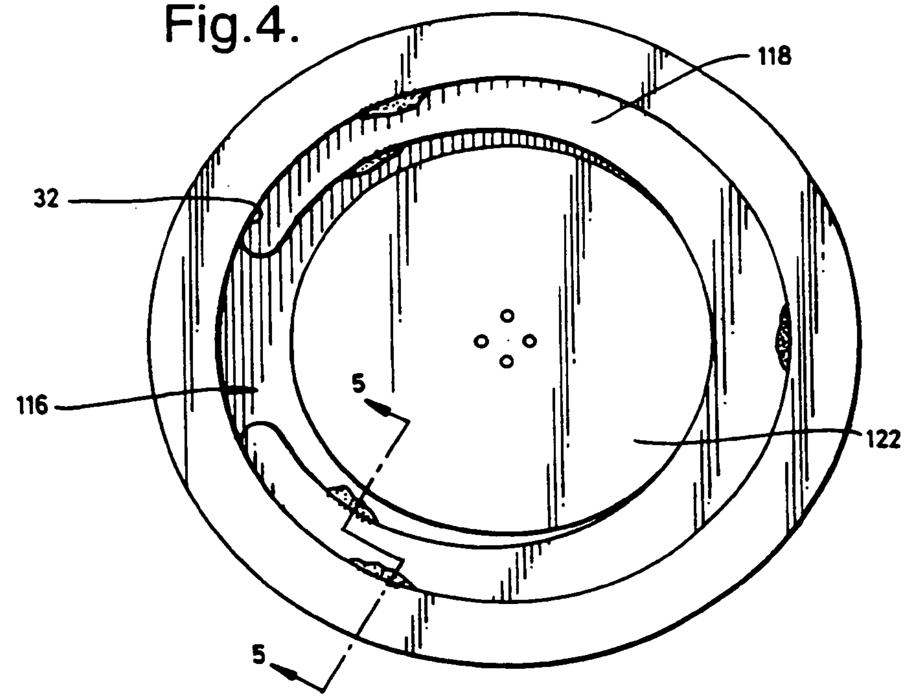

118
32
116
5
122
5

Fig.5.

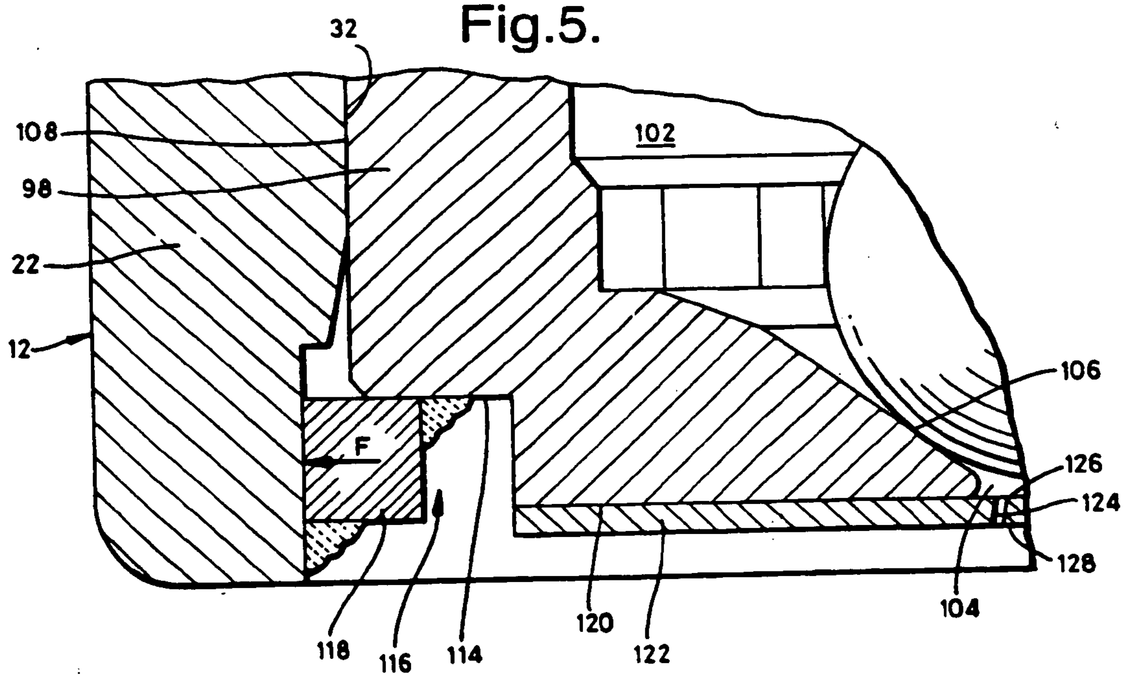

32
102
108
98
22
12
F
106
126
124
128
104
120
122
118
116
114

Fig.6.

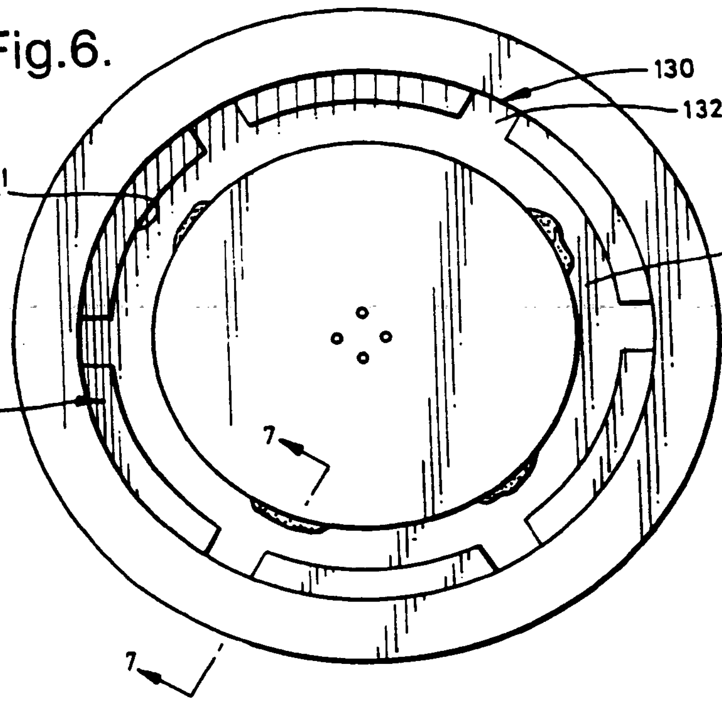
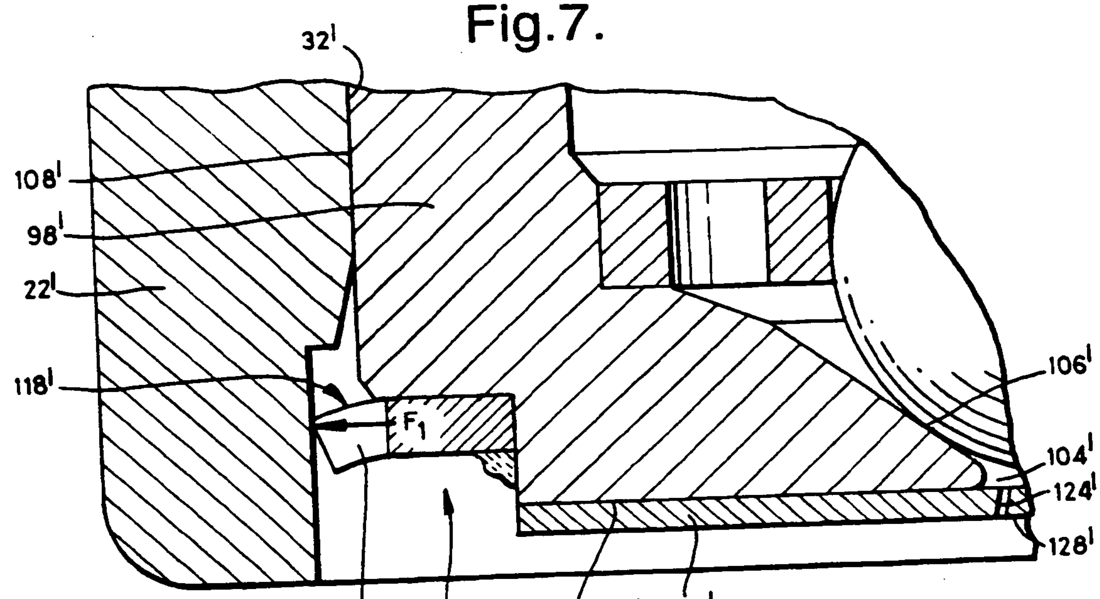

130
132
32'
118'
116'
7
7

Fig.7.


32'
108'
98'
22'
118'
F_1
106'
104'
124'
128'
132
116'
120'
122'

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 20 3325

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 335 864 A (ROMANN PETER ET AL) 9 August 1994 * column 1, line 30 - column 3, line 15; figure *	1,3-5,7	F02M61/18 F02M51/08
A	US 5 207 384 A (HORSTING JOHN J) 4 May 1993 * column 2, line 24 - line 47; figures 1,3 *	1,3-5,7	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 March 1997	Torle, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document